

WQS Revision: Chloride, Sulfate & TDS

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Presentation Outline

- Chloride criteria

- Why, when and how

- Sulfate Criteria

- Why, when and how

- Replacing TDS with specific ion criteria

- Benefit of the proposed criteria

- Water quality protection
 - Implementation and compliance

Acronyms and Basics

- LC50 = Concentration lethal to 50% of tested species in less than 48 or 96- hour acute testing
- Acute criterion = Short term effect
- Chronic criterion = Long term effect
- ACR = Acute-to-Chronic ratio
 - = Acute LC50/Chronic endpoint (NOEC)
 - ACR for rainbow trout is 7.308
 - ACR for daphnia is 3.187

Why: EPA 1988 Chloride Criteria

- Acute value = 860 mg/l
- Chronic value = 230 mg/l
- Derived from 12 genus species toxicity data
- Most sensitive:
 - Cladoceran: *Daphnia pulex*

When: IDNR Chloride Criteria Development in 2007

- Literature search
- Working with EPA Lab in Duluth
- TAC meeting in Nov. 2007
- More toxicity testing needed
 - Replicate of fingernail clam data
 - Effect of water chemistry, hardness & sulfate

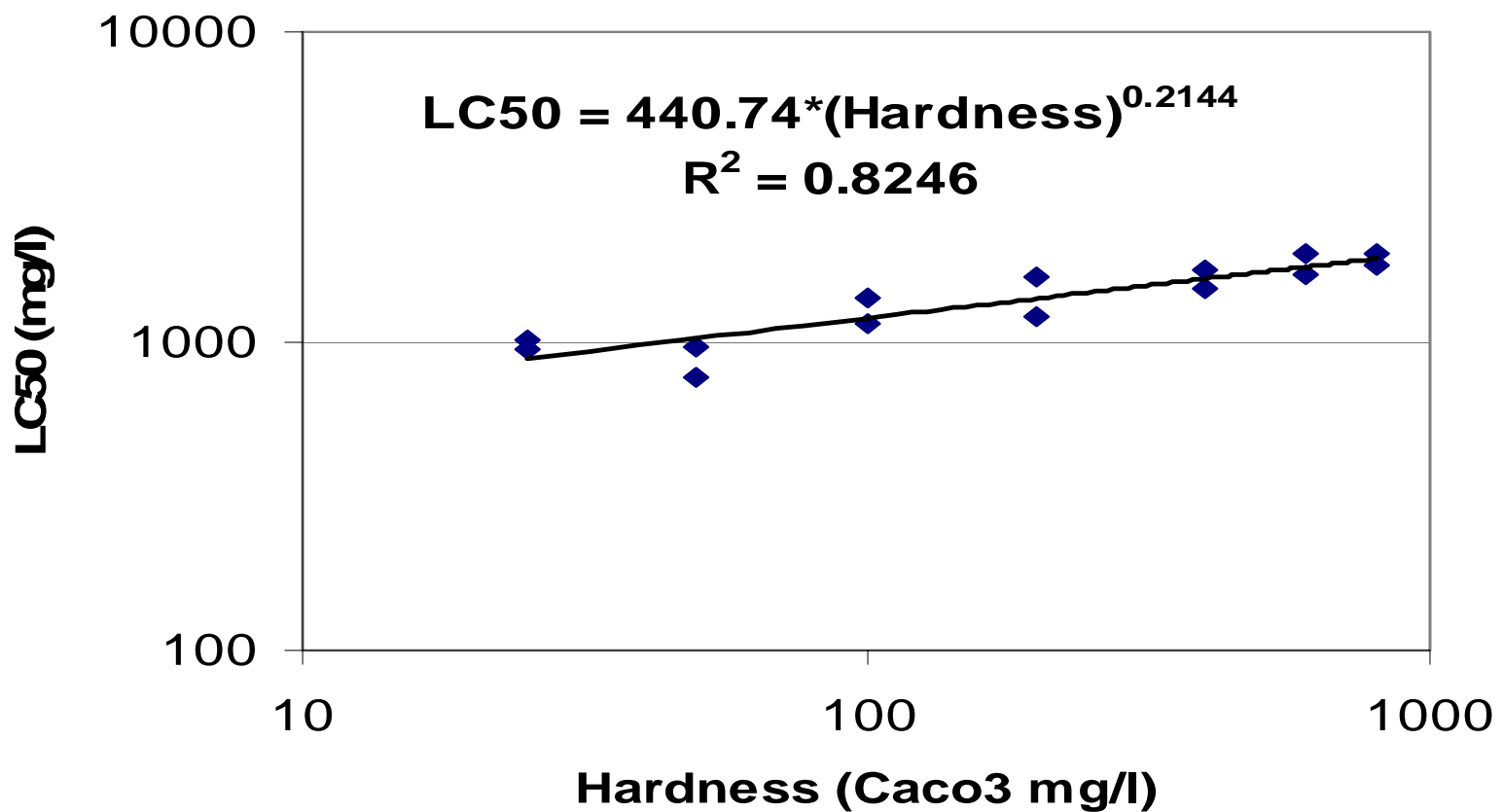
New Toxicity Testing for Chloride

■ Purpose of More Toxicity Testing

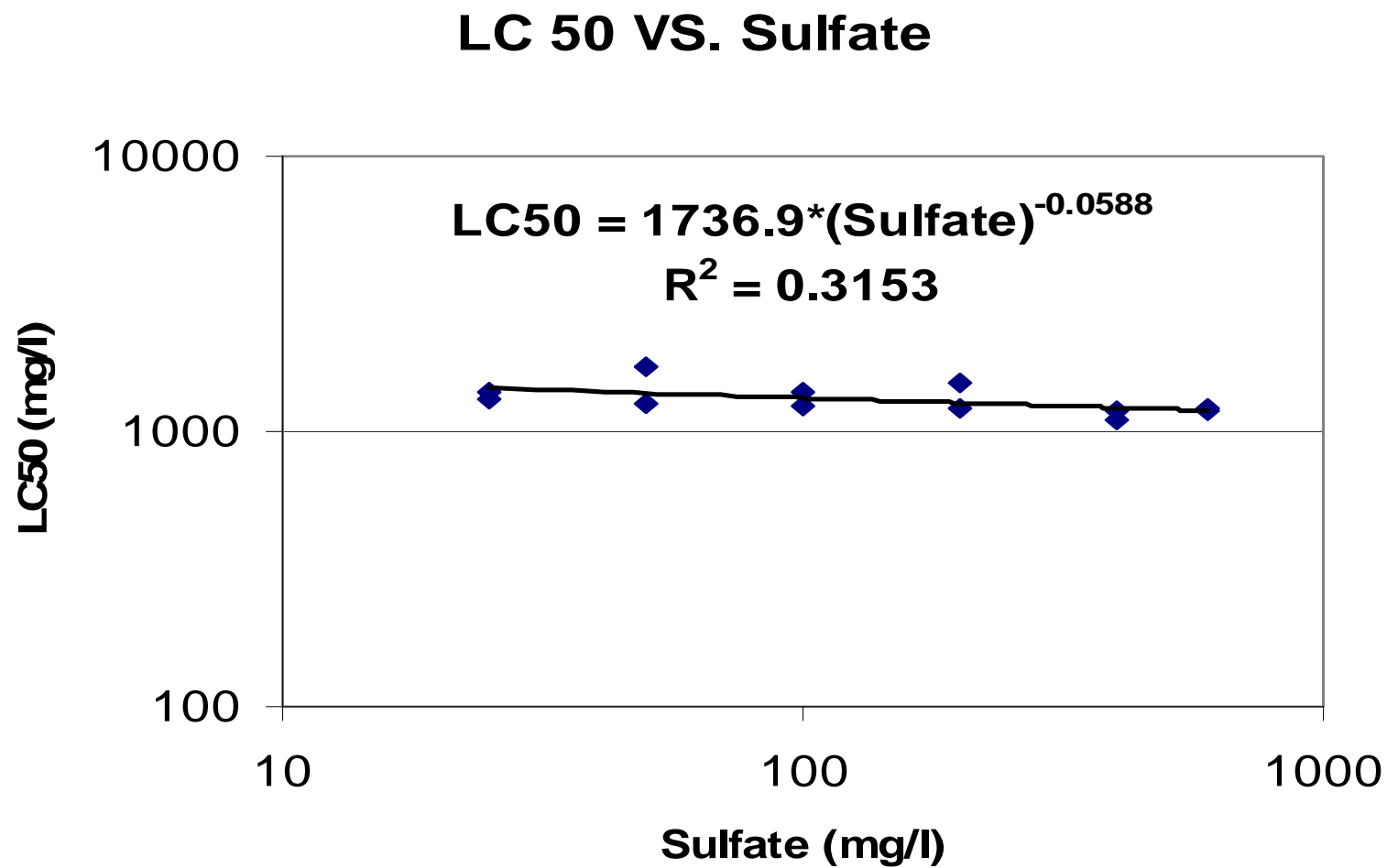
- Determine chloride acute toxicity to four species:
 - Water flea (*C. dubia*)
 - Fingernail clam (*Sphaerium simile*)
 - Planorbid snail (*Gyraulus parvus*)
 - Tubificid worm (*Tubifex tubifex*)
- Effect of hardness and sulfate on chloride toxicity
 - *C. dubia*
- EPA contracted GLEC and INHS Labs

Chloride LC50 vs. Hardness *C. dubia*

LC 50 VS. Hardness



Chloride LC50 vs. Sulfate *C. dubia*



HOW: Acute Criterion

- Using 1985 EPA Guidance
- A total of 23 species (an increase from 12 species in 1988 criteria)
- Acute Criteria Equation
 - A function of:
 - Hardness (significant impact)
 - Sulfate (lesser degree)
- $254.3(\text{hardness})^{0.205797} * (\text{sulfate})^{-0.07452}$

HOW: Chronic Criterion

- Predict chronic values from acute LC50s
 - Chronic endpoint = $LC50/ACR$
- For vertebrates, use ACR of rainbow trout (7.308)
- For invertebrates, use ACR of daphnia (3.187)
- The same method for developing acute criterion
- Chronic Criteria Equation
 - A function of:
 - Hardness (significant impact)
 - Sulfate (lesser degree)
- $161.5(\text{hardness})^{0.205797} * (\text{sulfate})^{-0.07452}$

Chloride Criteria Recalculation Results

Proposed Chloride Criteria	Number of Species (N = 23)
Acute Criterion	$254.3(\text{hardness})^{0.205797} * (\text{sulfate})^{-0.07452}$
Chronic Criterion	$161.5(\text{hardness})^{0.205797} * (\text{sulfate})^{-0.07452}$

Example Chloride Criterion Values

Hardness = 200 mg/l
Sulfate = 63 mg/l

Acute Value



556 mg/l

Hardness = 200 mg/l
Sulfate = 63 mg/l

Chronic Value

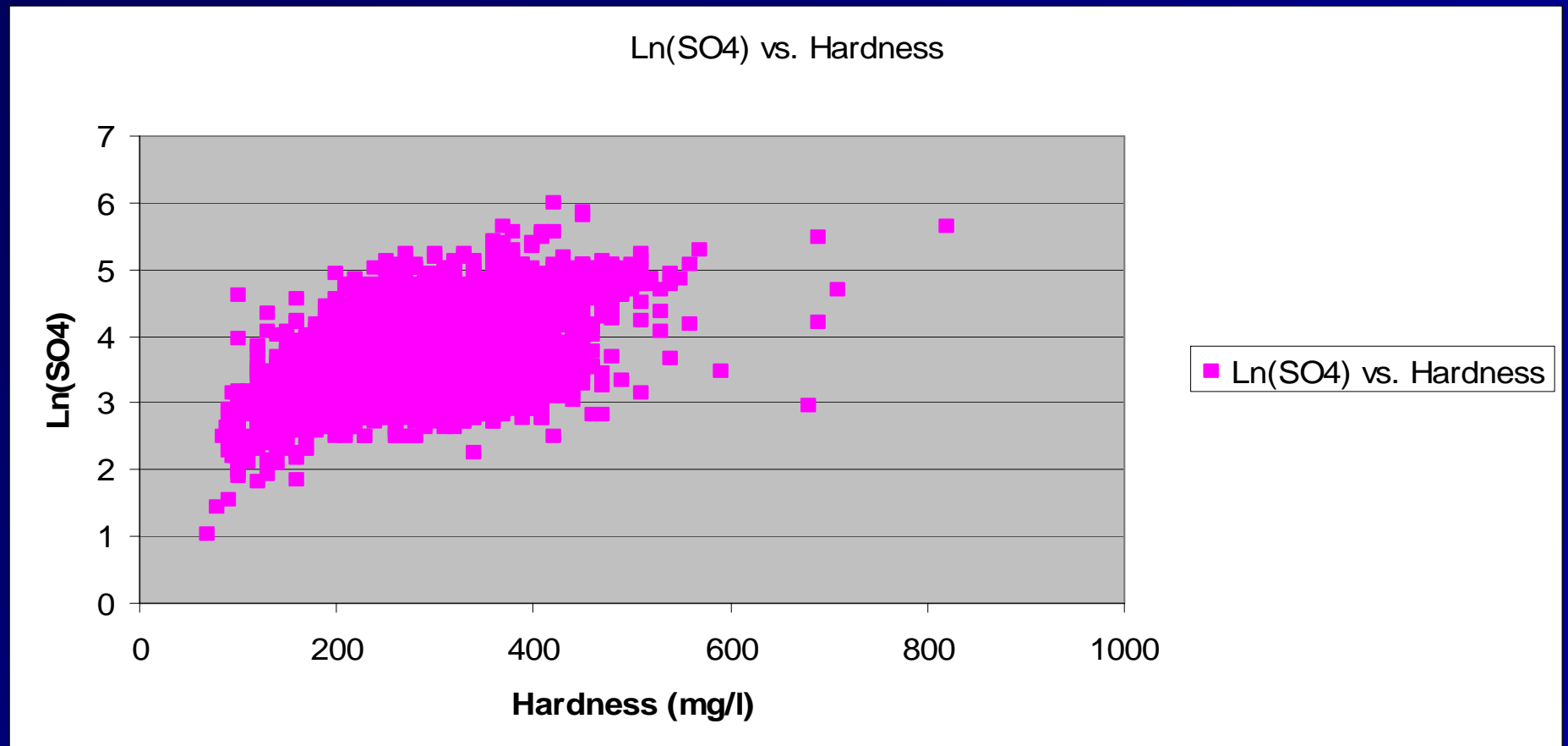


353 mg/l

Statewide Default Water Chemistry

- Statewide ambient monitoring data from 2000-2007
- 10th percentile HARDNESS value = 200 mg/l
- The corresponding SULFATE is selected by regression analysis of sulfate vs. hardness
- Statewide default water chemistry:
 - Hardness = 200 mg/l as CaCO₃
 - Sulfate = 63 mg/l

Correlation between Sulfate and Hardness



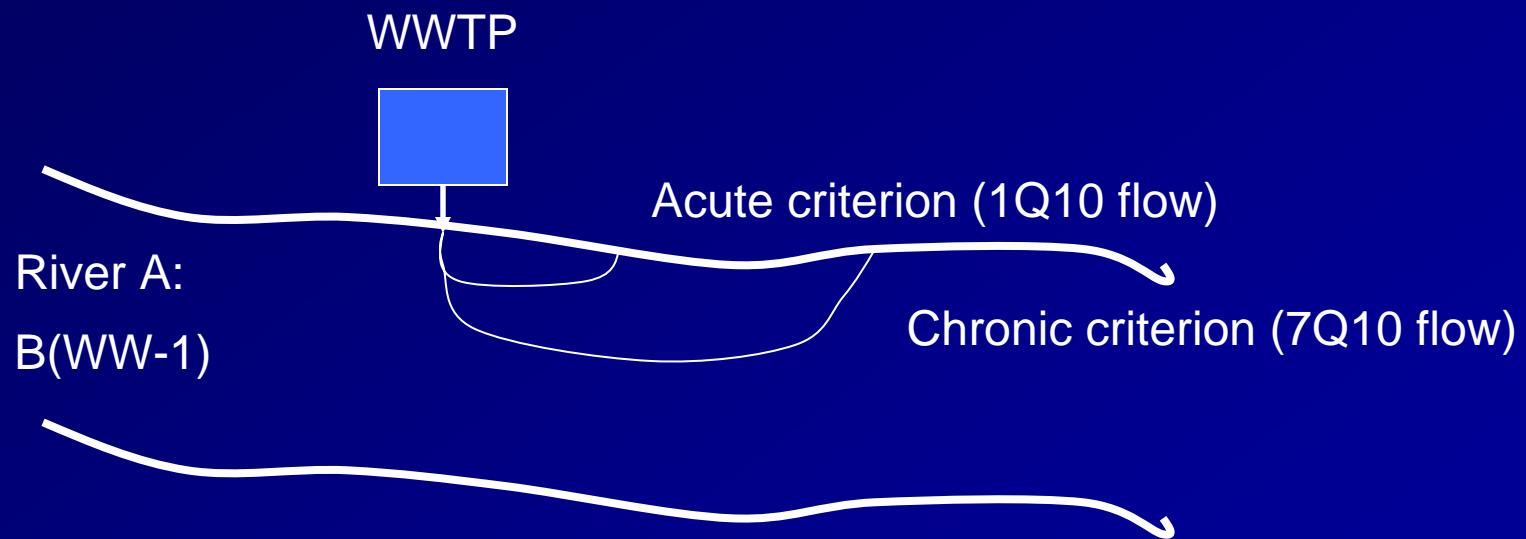
Chloride Criteria Based on Default Water Chemistry

Proposed Chloride Criteria	Criteria at Hardness = 200 mg/l and Sulfate = 63 mg/l
Acute Criterion	556
Chronic Criterion	353

Implementation of Chloride Criteria

Proposed Chloride Criteria	Location for Compliance
Acute Criterion	Beyond the Zone of Initial Dilution 2.5% 1Q10 flow
Chronic Criterion	Beyond the Mixing Zone 25% 7Q10 flow

Illustration of Chloride Criteria Implementation



Benefits of Chloride Criteria

- Based on defensible scientific toxicity data
- Easy to implement
- Incorporation of site-specific water chemistry in Iowa
- More appropriately protect Iowa's water quality

Sulfate Criteria

Sulfate Criteria Development

- NO national criteria
- Illinois worked with the USEPA Duluth Toxicity laboratory to search available toxicity test data on sulfate.
 - Data for over 30 kinds of organisms from about 30 papers/sources were found.
- Dr. David Soucek of the Illinois Natural History Survey was contracted to conduct additional toxicity testing
 - fill the toxicity data gap
 - Water flea, amphipod, Fingernail clam, Fatmucket
- Determine the effect of hardness and chloride on sulfate toxicity

Sulfate Criteria Applicable to Iowa

- The similarities of the landscape between the two States
- The similarities of water quality and resident species
- High level of scientific work

Sulfate Criteria

Table 2. Proposed Sulfate Criteria for Iowa Waters – Aquatic Life Criteria

Chloride Hardness mg/L as CaCO ₃	$\text{Cl}^- < 5 \text{ mg/L}$	$5 \leq \text{Cl}^- \leq 25$	$25 < \text{Cl}^- \leq 500$
$H < 100 \text{ mg/L}$	500	500	500
$100 \leq H \leq 500$	500	$[-57.478 + 5.79$ (hardness) + 54.163 (chloride)] * 0.65	$[1276.7 + 5.508$ (hardness) – 1.457 (chloride)] * 0.65
$H > 500$	500	2,000	2,000

In addition, a sulfate criterion of 2,000 mg/l for other uses such as livestock watering

Example Sulfate Criterion Values

Hardness = 200 mg/l
Chloride = 34 mg/l



1,514
mg/l

Sulfate Criteria Based on Default Water Chemistry

Proposed Chloride Criteria	Criteria at Hardness = 200 mg/l and Chloride = 34 mg/l
Acute Criterion	1,514 mg/l
Chronic Criterion	

Implementation of Sulfate Criteria

Proposed Chloride Criteria	Location for Compliance
Aquatic Life Criteria	Beyond the Zone of Initial Dilution 2.5% 1Q10 flow
Livestock Watering	Beyond the Mixing Zone 25% 7Q10 flow

Benefits of Sulfate Criteria

- Numerical criteria for aquatic life
- Based on defensible scientific toxicity data
- Easy to implement
- Incorporation of site-specific water chemistry in Iowa
- More appropriately protect Iowa's water quality

Revision of the Interim TDS Approach

What is TDS

- Total Dissolved Solids is a measure of all constituents dissolved in water
 - Inorganic anions include
 - carbonates, chlorides, sulfates and nitrates.
 - Inorganic cations include
 - sodium, potassium, calcium and magnesium.

Current Interim TDS Approach

- Adopted in 2004 as an interim approach
- If in-stream TDS > 1,000 mg/l, effluent toxicity testing
 - Both acute and chronic (for designated waterbodies)
 - Toxicity testing on fathead minnow and ceriodaphnia
- If in-stream Chloride > EPA 1988 criteria, effluent toxicity testing
 - Acute testing: chloride > 860 mg/l
 - Chronic testing: chloride > 230 mg/l
 - Toxicity testing on fathead minnow and ceriodaphnia

TDS Interim Strategy

- Depending on the discharge situation, effluent toxicity due solely to TDS may be less of a regulatory problem due to rapid dilution below toxic levels and the absence of human health or biomagnification concerns.
- The toxicity related to the ions in TDS is due to the specific combination and concentration of ions and is not predictable from TDS concentrations.

TDS Interim Strategy

- Integrative parameters such as conductivity, TDS, or salinity are not robust predictors of toxicity for a range of water qualities.
- Research recommends that different limits for individual ions, rather than TDS, be used for salmonid species.

Advantages of Ion Specific Criteria

- Developed based scientific toxicity data
- Easy to implement than narrative criteria
- Easy to check compliance
- Prevent over-protective or under-protective
- Pollutant specific criteria instead of integral parameters such as TDS, salinity etc.
- Incorporate site-specific conditions
- Resources will focus on source reduction

Timelines

- January 2009: Initiate Stakeholder Process
 - February 2009: Consultation Package to EPA
 - March 2009: Response from EPA
 - April 2009: Info item to EPC
 - May 2009: NOIA to EPC
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- Updates will be posted on our web page,
<http://www.iowadnr.gov/water/standards/index.html>